

## EXPERIMENTS, &amp;c., ON CAEN STONE.\*

TABLE A.—Chemical Analysis.†

	Gros Banc.	Banc de 4 Pieds.	Franc Banc.	Outside of St. Stephen's Chapel, Westminster.
Carbonate of lime .....	86.5	86.9	82.5	97.3
Silica .....	10.5	10.5	13.6	2.0
Alumina .....	3.0	2.2	3.2	0.7
Oxide of iron .....	A trace.	0.4	0.7	A very slight trace.
Magnesia .....	A trace.	A trace.	.....	.....

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TABLE B.—Weight of 6-inch Cubes.

	Ordinary state.			Thoroughly wet.			Thoroughly dry.			Weight absorbed.		
	lbs.	oz.	dr.	lbs.	oz.	dr.	lbs.	oz.	dr.	lbs.	oz.	dr.
Gros Banc .....	15	4	1	16	14	9	15	2	10	1	11	13
Pierre Franche .....	15	8	6	17	2	5	15	7	0	1	11	5
Banc de 4 Pieds .....	14	12	1	16	7	14	14	10	1	1	13	13
Pierre de 30 pouces .....	16	0	10	17	10	7	15	15	7	1	11	0
Franc Banc .....	14	8	4	16	5	14	14	5	12	2	0	2
Ranville .....	17	12	12	18	10	5	17	12	5	0	14	0
Aubigny .....	18	12	13	19	7	12	18	12	14	0	10	14

C. H. SMITH.

TABLE C.

Experiments upon Cubes of 2-inch Sides, on power to resist crushing.‡

Name of Quarry or Bed.	Pressure on bed.	Pressure on edge.
Gros Banc .. Top of block .....	Tons. 3.25	Tons. ....
" .. Middle do. ....	.....	8.05
" .. Do. do. ....	5.97	.....
" .. Bottom do. ....	2.97	.....
Pierre Franche .....	7.18	.....
" ..	.....	6.63
Banc de 4 pieds .....	2.57	.....
" ..	.....	2.38
Pierre de 30 pouces .....	3.35	.....
" ..	.....	2.67
Franc Banc .....	2.10	.....
" ..	.....	2.25
Ranville .....	6.2	.....
" ..	5.43	.....
" ..	.....	5.29
Aubigny .....	7.41	.....
" ..	10.78	.....
" ..	.....	9.78

GEORGE GODWIN, F.R.S.

THE accompanying tables show the physical and chemical properties of Caen stone. The specimens experimented upon were obtained direct from the quarries for this special purpose, and may be considered fair average samples of the stone which the beds respectively produce. Of the five beds from the Allemagne quarries, three have been subjected to analysis by Mr. Richard Phillips, F.R.S.—namely, the gros banc, the banc de 4 pieds, and the franc banc. It will be observed from table (A) that, as regards chemical composition, these three beds appear to be almost identical; and there is no reason to suppose that in this respect either of the other beds differs from them. The analysis of one specimen of old Caen stone, taken from the exterior of St. Stephen's Chapel, at Westminster, is placed in the table for comparison, because, in general appearance, this stone resembles that employed outside the oldest buildings at Caen. It has been exposed to the usual atmospheric influences for several centuries, and presents scarcely any symptoms of decay, therefore it will be interesting to see in what respects an old stone, well known to be durable, differs from the three samples obtained from the Allemagne quarries. In this instance we learn that a durable stone is composed almost entirely of carbonate of lime, with very small portions of other ingredients; whereas the franc banc, usually considered to be a perishable stone, contains a smaller quantity of carbonate of lime, and a larger amount of silica, than either of the other specimens.

Table (B) exhibits the avoirdupois weights of 6-inch cubes (one eighth of a cubic foot)—

\* See p. 38, ante.

† This, so far as we know, is the first analysis of the Caen stone which has been made. Considering that an analysis would be useful to the public, we solicited this from the Museum of Economic Geology, for which the public pay. The director of this establishment, however, considering perhaps that it was rather to benefit ourselves than the public that the application was made, declined to comply with it. We do not quarrel with the decision, but we venture nevertheless to remark that a contrary course would have been more gracious, and, we cannot help thinking, nothing more than the public and ourselves might expect. However, this being the case, we obtained the professional assistance of a gentleman (connected, too, with the Museum), in whom our readers will place confidence, Professor R. Phillips, and, though probably the half-dozen lines, the result of his investigation, will not lead to the sale of so many additional copies of *THE BUILDER* as they cost pains to obtain, the occurrence will, we trust, serve to show our anxiety to place the subject before our readers in as perfect a form as possible.—Ed.

‡ Three experiments were made at Thames Bank (by the kind permission of Mr. Cahill), with the assistance of Mr. Dineo and an excellent hydrostatic press. The singular and striking difference in the results of the experiments on the gros banc is attributable to the varying strength of different parts of the stone, even in cubes of 3 inches adjoining each other in the block. This fact makes the table of comparatively little value towards determining the strength lost or gained by placing the blocks in a building the same way as in the bed.—Ed.

first, the weights of the specimens in the state in which the stones are usually employed for building purposes, having only been squared, and placed under an open shed, exposed to the atmosphere for several weeks.

The second column indicates the weights of the same cubes, after having been immersed in water forty-eight hours, so as to become completely saturated, such weights having been ascertained immediately after the cubes were taken out of the water, and wiped with a dry cloth.

The third column contains the weights of the same specimens, after having been perfectly dried, in a hot-air chamber, for several days; in the meantime, being frequently weighed, until ultimately they ceased to decrease in weight.

The fourth column shows the difference of weight between the same specimens, in their dried and in their saturated state; and indicates, therefore, the quantity (by weight) of water absorbed by each stone.

Table (C) shows the results of experiments relating to the cohesive strength of the stones, or their resistance to pressure, made with a hydrostatic press, under the eye of Mr. Godwin, upon cubes of 2-inch sides, in duplicate: the figures represent tons and decimals of a ton. The chief value of this table is to determine, if possible, whether any difference exists in the cohesive strength, if crushed with the pressing surfaces parallel to the horizon, as the stone lay in the quarry, or if the pressure be applied edgewise. It has long been the custom to attribute all failures of perishable stone to inattention in not placing them in the building on their natural bed. In a recent number of *THE BUILDER* (309, January 6th), a correspondent, advocating the use of Bath stone for a church at Liverpool, states that, "Nine-tenths of the failures imputed to this stone have occurred through the ignorance or inattention of workmen or superintendents in neglecting to work the stones, so as to lay on their natural beds, which has laid the pores of the stone open to the effects of rain and frost." From my childhood this has been the universal theme of those who are half-learned in such matters. It is easy to determine the bed-way of sandstones; but with reference to limestones and oolites, in the absence of fossil remains—and such things are of extremely rare occurrence in either Bath or Caen stone—I cannot discover any means of detecting the slightest symptom of lamination, or, when once a block of Caen stone has been disturbed, of saying which way it lay in the rock. I have frequently heard this question discussed, during the last 30 years, by many

intelligent practical masons, and others conversant with the subject, who have professed their ability to determine, to a certainty, which is the bed way of a specimen of Bath or Caen stone. But, although I have grown grey in the service, I candidly confess that I am still ignorant upon the subject; and must either be extremely dull of comprehension or they are deficient in the means of communicating this learning to a "brother chip." The importance of such precaution is generally very considerably overrated; I do not think it signifies which way a stone is fixed unless it presents a decidedly laminated structure, which scarcely ever occurs amongst the oolites. A stone of an open, powdery, and slightly cemented texture will, if exposed to the weather, decompose in a comparatively short space of time, in whatever direction it may be fixed, or whichever surface may be parallel to the horizon.

Throughout the whole of these investigations and experiments, the utmost care has been taken to attend to the marks, indicating the uppermost side of the stones, with reference to their position in the quarry; thereby to insure the greatest accuracy, especially as regards cohesive strength. The table of experiments now under consideration, will do little or nothing towards proving that there is an appreciable difference in crushing the stones flatwise, or edgewise, of the bed. According to theory, we might expect that they would bear a greater pressure, if applied parallel to the bed, than if edgewise: in the table before us, there is very little difference, and in two cases out of the seven, namely, the gros banc and the franc banc, the specimens bore a greater force edgewise than on their bed.

Were it possible to determine this question to a certainty, so that the mason would have no difficulty in ascertaining the bed, or in working the stones for a building, so as to lay them all on their natural bed, the cost of masonry would then be greater, because he would frequently have to cut the blocks to a great disadvantage.

C. H. SMITH.

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